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Yield maximization and its economics in rice (*Oryza sativa* L) grown during cold season

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Abstract : Field experiments were conducted for three years (1994-1995 to 1996-1997) during cold season (winter) to find out suitable nutrient management for yield maximization in rice. The growth characters and yield attributes were markedly influenced by the treatments. Application of 20 per cent extra N in addition to 150 : 50 : 50 kg N, P_2O_5 and K_2O ha^{-1} surpassed other treatments. A fertilizer dose of 180 : 50 : 50 kg N, P_2O_5 and K_2O ha^{-1} was found best for maximizing the yield of medium duration rice grown during cold season.

Key words: *Rice, Cold season, Yield, Economics, Uptake.*

Introduction

In the North western agro climatic zone of Tamil Nadu, rice is grown in an area of about 1.34 lakh hectares and the average productivity is much less as compared to the State average. The crop is being transplanted in winter season (during the second week of December) when water is normally available in the canal and hence, most of the crop growth period synchronize with the cold weather. It is needless to mention that during this season, the temperature is low resulting in a draustic reduction on the N availability. Under such condition, the plant is deprived from sufficient N and as a result, the crop exhibits chlorosis and stunted growth. Eventhough the P availability is more under submerged condition, the process is inhibited during cold weather period due to poor reduction of iron compounds. Though K nutrition is not a major problem in rice culture, low temperature also minimizes the translocation process. The availability of micro nutrients especially Zn is aslo affected. Considering these, this study was aimed to investigate the best suited nutrient management for rice grown during cold season for maximizing the yield and economics.

Materials and Methods

Field experiments were conducted for three years during the cold (winter) seasons of 1994-1995 to 1996-1997. The soil was loamy sand in texture with pH 7.8 and the EC 0.22 dSm^{-1}. The experimental soil was low in organic carbon (0.37%) and available N (218 kg ha^{-1}), medium in available P (14.0 kg ha^{-1}) and available K (187 kg ha^{-1}). The nine treatments included: T_1 - Control ; T_2 - 100% NPK (150: 50: 50 kg ha^{-1}) as soil application (Blanket); T_3 - T_2 + 20% extra N (180: 50 : 50 kg NPK ha^{-1}) as soil application; T_4 - 50% N + 100% PK (soil) + 2.5 % urea foliar spray at active tillering (AT) and panicle initiation (PI) ; T_5 - 100% PK (soil) + 2.5% Urea foliar spray at AT, PI, mid heading (MH) , first flowering (FF) and 50 per cent flowering (F) ; T_6 - T_2 + Phosphobacterium (2 kg ha^{-1}) ; T_7 - T_2 + 25 kg $ZnSO_4$ ha^{-1} (soil application) ; T_8 - T_2 + 2% DAP foliar spray at AT and PI and T_9 - T_2 + 1% $ZnSO_4$ foliar spray at AT and PI stages. The treatments were replicated thrice in a randomized block design. Medium duration rice (Paiyur 1) was transplanted during second week of December and harvested during first week of April. The fertilizer P_2O_5 and $ZnSO_4$ were applied basally and soil application of N and K_2O was done in three splits *viz.* 50 per cent as basal and remaining 50 per cent in two splits at active tillering (AT) and panicle initiation (PI) stages. Yield attributes, grain and straw yield were recorded. The harvest index (HI) and economics were worked out. The plant samples were analysed for total N (Humphries,1956), P and K (Jackson,1973) and uptake computed. Soil samples (0-15 cm) collected at harvest were analysed for available N (Subbiah and Asija, 1956), P (Watenabe and Olsen, 1965) and K (Hanway and Heidal, 1952). The rainfall received during the cropping period in the three years was 75.0, 232.2 and 225.6 mm, respectively. The mean minimum and mean maximum temperatures ranged from 18.4 to 19.4°C and 33.3 to 34.5°C, respectively.

Results and Discussion

Growth and Yield attributes

The plant height differed significantly (90.4 to 101.9 cm). Application of 180 kg N ha^{-1} with

Table 1. Yield attributes, yield and economics in rice (Mean over three years)

Treatment	Yield attributes					Yield ($kg\ ha^{-1}$)		Harvest index (%)	Economics	
	Height (cm)	Productive tillers $hill^{-1}$	Grains $panicle^{-1}$	Chaff $panicle^{-1}$	Grain test weight (g)	Grain	Straw		Net income (Rs ha^{-1})	B/C ratio
T_1	90.4	6.5	131	10.9	15.5	3766	5733	39.65	16579	4.25
T_2	99.7	9.4	192	9.4	16.8	6176	8333	42.57	27682	4.76
T_3	101.9	10.0	189	10.9	16.8	6713	9183	42.23	30568	5.03
T_4	92.9	8.2	191	12.4	16.7	6110	8150	42.85	27750	5.02
T_5	89.3	8.3	184	11.0	16.0	5597	7530	42.64	25331	4.91
T_6	99.2	8.7	179	10.9	16.4	6337	8356	43.13	28448	4.84
T_7	99.3	9.1	186	10.2	16.8	6329	8290	43.29	28075	4.64
T_8	99.6	8.8	198	14.7	16.6	6536	8664	43.00	29499	4.93
T_9	98.5	9.0	166	11.5	16.8	6510	8677	42.87	29389	4.92
CD (P=0.05)	4.2	1.2	26.9	NS	0.46	592	1335	-	-	-

P and K (T_3) recorded the maximum plant height of 101.9 cm. The least plant height of 89.3 cm was associated with T_5 (full foliar spray of N) which was again at par with control and T_4 treatment (50% N as soil application + 2.5% urea foliar spray at AT and PI stages). Similar to plant height, the productive tillers also varied markedly. A value of 6.5 tillers $hill^{-1}$ in control got enhanced to 10.0 tillers $hill^{-1}$ under the treatment T_3 (180 kg N + P and K). Comparing with the control, other treatments also recorded significant differences with a mean range of 8.2 to 9.4 tillers $hill^{-1}$ (Table 1). Improvement in yield attributes with N application corroborates with the findings of Singh and Sharma (1993).

While the control remained to be inferior, all the fertilized treatments could prove their superiority in respect of the grains $panicle^{-1}$. The treatment T_8 (T_2 + 2% DAP foliar spray) was associated with the highest of 198 grains $panicle^{-1}$ closely followed by T_2 and T_4. The control recorded only 131 gains $panicle^{-1}$. The chaff $panicle^{-1}$ was not altered by the treatments appreciably. However, the grain test weight in terms of 1000 grains varied significantly from 15.5 to 16.8 g. All the treatments receiving fertilizer remained at par but superior over control.

Yield

The grain yield of mere 3766 kg ha^{-1} in control got increased spectacularly with the treatments varied from 5597 to 6713 kg ha^{-1} (Table 1). This implies that there was positive response of rice to fertilizer application grown during the cold season. Application of 20 per cent extra N over and above the treatment T_2 recorded the highest yield of 6713 kg grain ha^{-1} accounting for 78.3 per cent yield increase over control and 8.7 per cent over T_2 (150:50:50 kg ha^{-1} N, P_2O_5 and K_2O). Nambiar and Abrol (1989) reported 8.6 per cent yield increase in gain with the application of 150 per cent recommended fertilizer level. Supplementation of mere 20 per cent N (30 kg ha^{-1}) itself could increase the yield to the tune of 537 kg ha^{-1} over T_2. The above findings clearly indicate that the rice crop grown during winter season was highly under N starvation and an additional dose of N had favoured the crop in terms of nutrients availability. The treatments involving 2 per cent DAP (T_8) and 1 per cent $ZnSO_4$ (T_9) as foliar spray rated next best by recording 6536 and 6510 kg ha^{-1} with an yield improvement of 5.8 and 5.4 per cent, respectively over T_2. The yield increase due to DAP spray might be through better grain filling and enhanced grain weight. Spraying of $ZnSO_4$ would have favoured

Table 2. Nutrient uptake (kg ha^{-1}) and content (%) of rice and soil fertility (Mean over three years)

Treatment	Nitrogen		Phosphorus		Potassium		Soil available nutrients (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	N	P	K
T_1	35.7 (0.99)	26.5 (0.48)	7.7 (0.203)	4.8 (0.090)	9.8 (0.27)	51.5 (0.93)	222.3	10.73	176.3
T_2	76.9 (1.26)	45.1 (0.57)	1404 (0.233)	6.7 (0.103)	18.9 (0.31)	105.7 (1.37)	275.0	13.77	206.7
T_3	77.5 (1.16)	50.3 (0.57)	16.3 (0.243)	9,6 (0.107)	20.9 (0.31)	131.9 (1.50)	278.0	13.80	212.3
T_4	62.3 (1.06)	39.9	14.0 (0.223)	8.1 (0.100)	19.2 (0.36)	96.0 (1.20)	266.3	14.07	215.7
T_5	57.1 (1.04)	46.4 (0.63)	13.1 (0.230)	7.2 (0.100)	17.6 (0.32)	91.7 (1.23)	235.0	14.30	218.7
T_6	65.2 (1.07)	42.2 (0.53)	15.4 (0.240)	8.9 (0.107)	19.6 (0.31)	95.9 (1.20)	267.0	16.23	211.7
T_7	66.9 (1.09)	40.5 (0.44)	15.7 (0.247)	8.9 (0.110)	19.8 (0.32)	93.1 (1.13)	277.7	14.00	226.7
T_8	74.0 (1.15)	40.0 (0.50)	16.1 (0.243)	9.1 (0.117)	18.5 (0.29)	93.4 (1.10)	284.7	14.27	217.0
T_9	72.4 (1.14)	43.3 (0.53)	15.7 (0.237)	9.2 (0.110)	21.6 (0.34)	104.7 (1.23)	266.0	13.80	211.3
CD (P=0.05)	13.8 (NS)	8.7 (NS)	2.17 (NS)	1.79 (NS)	3.1 (NS)	18.7 (NS)	19.6	1.43	20.5

(Figures in parenthesis denotes content)

translocation of N besides encouraging balanced nutrition. The treatment involving only foliar spray of N at important growth stages without soil application (T_5) though proved its superiority (5597 kg ha^{-1}) over control, it could not compete with other treatments (Table 1). The rice crop probably was not able to meet its N requirements fully in the absence of soil application. The above findings are again confirmed by the increased yield of T_4 which received N through both soil and foliar. Integration of phosphobacterium (T_6) and $ZnSO_4$ (T_7) with T_2 also played a favorable role by registering 6337 and 6329 kg grain ha^{-1}, respectively. The phosphobacterium by virtue of its nature might have increase solubulization providing a conducive atmosphere for better root growth, foraging area and better gain filling.

Though the straw yield varied significantly, all the treatments except T_2 and T_5 were at par. The treatment T_3 was the best by recording 9183 kg ha^{-1} followed by T_9 and T_8 while the control recorded the least (5733 kg ha^{-1}) and remained to be inferior to all treatments. The harvest index ranged from 39.65 to 43.29 per cent among the treatments evaluated. Combined application of 100 per cent NPK and $ZnSO_4$ through soil recorded 43.29 per cent followed by the treatment T_6 (43.13%) and T_8 (43.00%). While the control (T_1) was associated with 39.65 per cent.

Economics

Consideration of the economics in terms of net return, the results clearly indicated the beneficial nature of treatments and the net income ranged from as low as Rs.16,579 ha^{-1} (control) to Rs.30,568 ha^{-1} in T_3 treatment (Table 1). Foliar spray of DAP and $ZnSO_4$ rated next best with Rs.29,499 and Rs.29,389 ha^{-1} , respectively. The B/C ratio also followed the same trend. It is obvious from the above that by adopting suitable N management, a better yield and returns could be expected from rice grown during cold season.

Content and uptake

The content of N, P and K both in the grain and straw though exhibited variations, the differences were not significant. Tiwana *et al.*

1999) also observed no variation in tissue N, P and K content of rice under different levels of fertilizer schedule. The treatment T_3 (T_2 + 20% extra N) recorded 77.5 kg ha^{-1} grain N uptake accounting for about two fold increase over control (35.7 kg ha^{-1}). Except T_4 and T_5 treatments, all other treatments also proved to be more efficient by recording on par uptake (65.2 to 76.9 kg ha^{-1}). However in the straw, the treatments had a differential influence. The highest uptake was associated with the treatment T_3 (50.3 kg ha^{-1}) but was at par with the treatments T_5 and T_2. Though better performed in the grain uptake, the treatments T_6 to T_9 could not compete with the above treatments in straw N uptake. This might be due to better translocation of N from straw to grain by the treatments T_3 and T_6 to T_9. The present finding of higher N uptake in grain and straw due to higher levels of N find support from Singh and Singh (1998).

The P uptake in the gain ranged from 7.7 to 16.3 kg ha^{-1}. While the control remained to be far behind from other treatments, the treatment T_3 rated the best by recording 16.3 kg ha^{-1}. Similar to N, among the fertilized treatments, except T_4 and T_5 treatments, all other treatments were at par with the treatment T_3. The straw P uptake ranged from 4.8 to 9.6 kg ha^{-1} and the treatmental differences were similar to gain P uptake.

The K uptake of mere 9.8 kg ha^{-1} in control had increased to 18.9 kg ha^{-1} with the treatment T_2 and got further enhanced to 20.9 kg ha^{-1} under T_3 treatment in the grain. A maximum uptake of 21.6 kg ha^{-1} was associated with T_9. Among the treated plots, T_5 continued to be inferior by recording 17.6 kg ha^{-1} and however, it had recorded almost a two fold increase in the grain K uptake and the performance could not be under estimated. The straw K uptake varied spectacularly and the treatment T_3 proved its superiority with 131.9 kg ha^{-1}. Except control, all the other treatments were at par with each other with a range from 91.7 to 104.7 kg ha^{-1}. The control recorded only 51.5 kg ha^{-1} and remained inferior to other treatments.

Available nutrients

The available N in the soil ranged from 222.3 to 284. 7 kg ha^{-1}. Through all the treated plots were statistically equivalent, but proved their superiority over control. The treatments T_8, T_7, T_3 and T_2, deserved special mention which exhibit better yield and uptake besides had left higher residual soil N. The available P of 16.23 kg ha^{-1} in the treatment T_6 was significantly higher over all other treatments. This was the treatment which received phosphobacteria and perhaps the more availability of P might be the contribution from bacteria through its capacity to mobilize P where as the control recorded only 10.73 kg ha^{-1}. The available K varied significantly and all the treated plots though remained at par by recording 206.7 to 226.7 kg ha^{-1} proved their superiority over control (176.3 kg ha^{-1}). The relatively higher availability of 226.7 kg ha^{-1} was recorded by the treatment T_7.

It was concluded that application of 180 kg N ha^{-1} with recommended P and K (50 kg ha^{-1} each) was advantageous for obtaining higher yield and monetary returns in medium duration rice grown during cold season in loamy sand soils.

References

Hanway, J.J. and Heidal, H. (1952). Soil analysis methods as used in Iowa State College Soil Testing Laboratory. *Iowa State College Agric. Bull.* **57**: 1-13.

Humphries, E.C. (1956). Modem methods of soil analysis. Springer-Verlag. *Berlin* **1**: 468-502.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India, Pvt. Ltd., New Delhi.

Nambiar, K.K.M. and Abrol, I.P. (1989). Long-term fertilizer experiments in India - An Overview. *Fert. Newsl.* **34**: 11-23.

Singh, K.N. and Sharma, D.K. (1993). Effect of seedling age and nitrogen levels in yield of rice on a sodic soil. *Fld. Crops Res.* **31**: 309-316.

Singh, R.S. and Singh, S.B. (1998). Response of rice *(Oryza sativa)* to age of seedlings and level and time of application of nitrogen under irrigated condition. *Indian J. Agron.* **43**: 632-635.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci.* **5**: 656-659.

Tiwana, U.S., Narang, R.S. and GosaL, K.S. (1999). Nutrient management for yield maximization of rice *(Oryza sativa)* - wheat *(Triticum aestivum)* cropping system. *Indian J. Agron.* **44**: 1-7.

Watenabe, F.S. and Olsen, S.R. (1965). Test of an ascarbic acid method for determination of phosphorus in water and $NaHCO_3$ extracts from soil. *Soil Sci. Soc. Am. Proc.* **29**: 677-679.

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